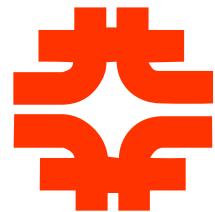
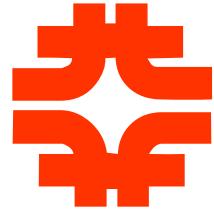


Beams Division Preparation for Run IIb

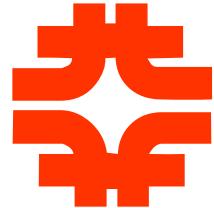


Dave McGinnis
April 20, 2001



Run II Luminosity Goals

- The luminosity goal for Run IIa is 2 fb^{-1}
 - Peak luminosity up to $2 \times 10^{32} \text{ cm}^{-2}\text{sec}^{-1}$
 - Switch to 103 bunches at $1 \times 10^{32} \text{ cm}^{-2}\text{sec}^{-1}$
 - Length of Run IIa is about 2 years
- The luminosity goal for Run IIa+Run IIb is 15 fb^{-1}
 - Increase antiproton intensity by 2-3
 - Peak luminosity up to $5 \times 10^{32} \text{ cm}^{-2}\text{sec}^{-1}$
 - 103 bunch operation
 - Length of Run IIb is about 4 years



Run II Parameters

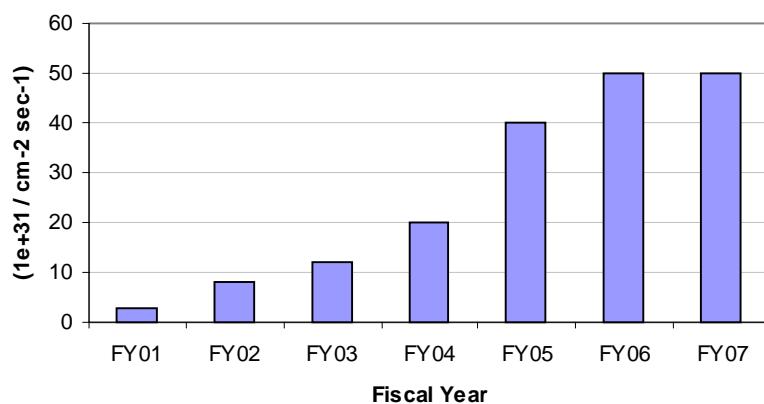
RUN	Ib (1993-95) (6x6)	Run IIa (36x36)	Run IIa (140x105)	Run IIb (140x105)	
Protons/bunch	2.3×10^{11}	2.7×10^{11}	2.7×10^{11}	2.7×10^{11}	
Antiprotons/bunch*	5.5×10^{10}	3.0×10^{10}	4.0×10^{10}	1.0×10^{11}	
Total Antiprotons	3.3×10^{11}	1.1×10^{12}	4.2×10^{12}	1.1×10^{13}	
Pbar Production Rate	6.0×10^{10}	1.0×10^{11}	2.1×10^{11}	5.2×10^{11}	hr^{-1}
Proton emittance	23π	20π	20π	20π	mm-mrad
Antiproton emittance	13π	15π	15π	15π	mm-mrad
β^*	35	35	35	35	cm
Energy	900	1000	1000	1000	GeV
Antiproton Bunches	6	36	103	103	
Bunch length (rms)	0.60	0.37	0.37	0.37	m
Crossing Angle	0	0	136	136	μrad
Typical Luminosity	0.16×10^{31}	0.86×10^{32}	2.1×10^{32}	5.2×10^{32}	$\text{cm}^{-2}\text{sec}^{-1}$
Integrated Luminosity [†]	3.2	17.3	42	105	$\text{pb}^{-1}/\text{week}$
Bunch Spacing	~3500	396	132	132	nsec
Interactions/crossing	2.5	2.3	1.9	4.8	

[†]The typical luminosity at the beginning of a store has traditionally translated to integrated luminosity with a 33% duty factor. Operation with antiproton recycling may be somewhat different.

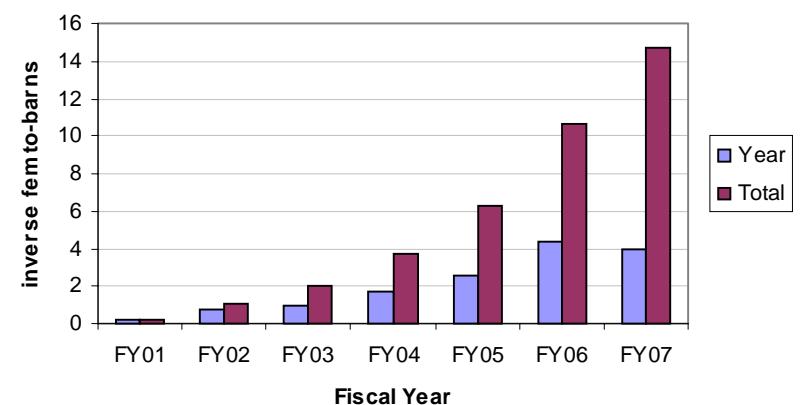


Run IIb Luminosity Schedule

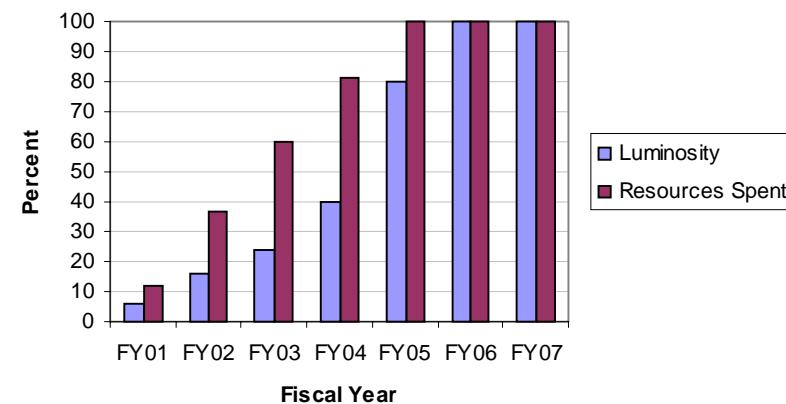
Initial Store Luminosity

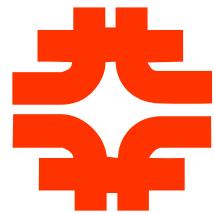


Integrated Luminosity

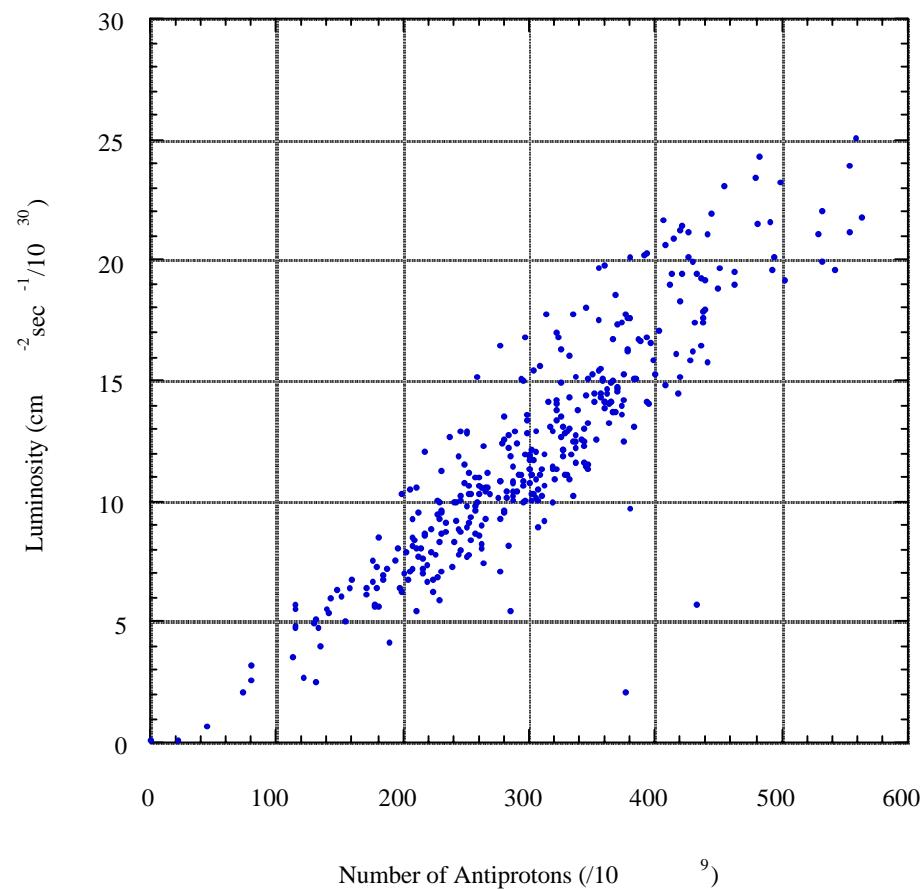


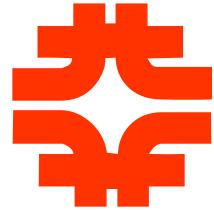
Initial Luminosity & Resources Spent





Luminosity vs. Antiproton Intensity

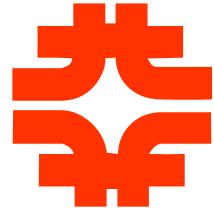




The Run IIb Plan

Increase the number of antiprotons in the collider by a factor of 2-3 over Run IIa

- without major interruption to Run IIa
- within a period of 2-3 years
- with a modest budget
- with a relatively small number of people



More Antiprotons

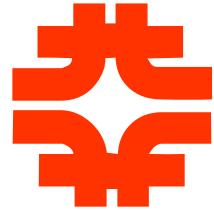
- More protons on the antiproton target (~1.8 x)

- Slip stacking

- MI Beam loading compensation
 - Booster Cogging
 - Proton beam sweeping

- Brighter Proton Source

- Brighter Ion Source
 - New Linac front-end acceleration stage



More Antiprotons

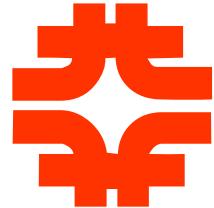
- Better antiproton collection efficiency

- Lithium lens Upgrade (~1.5 x)

- Solid lens redesign
 - Liquid Lithium lens

- AP2-Debuncher aperture increases (~1.5 x)

- Physical aperture increases and beam based alignment
 - Debuncher lattice Upgrades



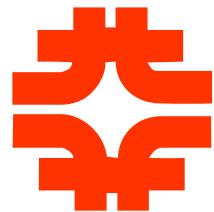
Handling the Increased Antiproton Flux

- Better cooling

- ❑ Debuncher cooling bandwidth increase
 - ❑ Accumulator Stacktail
 - Gain slope redesign
 - Betatron Cooling
 - ❑ Accumulator Core bandwidth and sensitivity increase
 - ❑ Electron cooling in the Recycler

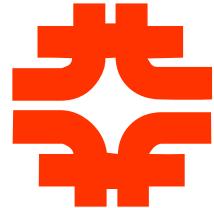
- Better Antiproton Transfer Efficiency

- ❑ Dedicated Accumulator to Recycler 8 GeV transfer line (AP5)



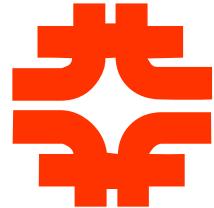
Run IIb Projects and Project Leaders

- 1. Slip Stacking - Steimel
 - More protons on target
- 2. MI Beam loading - Reid
 - More protons on target
- 3. AP5 line - Lebedev
 - Better antiproton transfer efficiency
- 4. AP2 & Debuncher Aperture Upgrades - Gollwitzer
 - Better antiproton collection efficiency
- 5. Solid Lens R&D - Hurh
 - Better antiproton collection efficiency



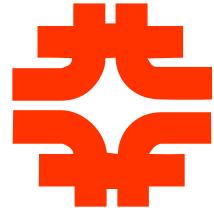
Run IIb Projects and Project Leaders

- 6. Accumulator Cooling - [Derwent](#)
 - [Better cooling](#)
- 7. Recycler Electron Cooling - [Nagaitsev](#)
 - [Better cooling](#)
- 8. Debuncher Lattice Upgrades - [Werkema](#)
 - [Better antiproton collection efficiency](#)
- 9. Linac Ion Source - [Dudnikov or Moehs](#)
 - [More protons on target](#)
- 10. TEV Tune shift compensation - [Shiltsev](#)
 - [More protons at collisions](#)



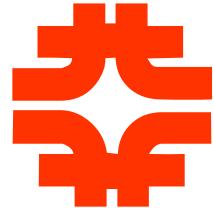
Run IIb Projects and Project Leaders

- 11. Booster ramped correctors - Webber or designee
 - More protons on target
- 12. Booster cogging - Webber or designee
 - More protons on target
- 13. TEV. Long dampers - Tan
 - More protons at collisions
- 14. TEV Beam loading - Tan
 - More protons at collisions
- 15. Liquid Lens R&D - Leveling
 - Better antiproton collection efficiency



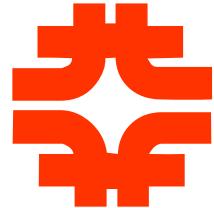
Run 2b Organizational Goals for CY2001

- Design Report Rough Draft for next Accelerator Advisory Committee (AAC) meeting (May 21-22, 2001)
 - Description of overall Run 2b plan will be written.
 - Rough draft will include only the scope of each Run 2b project.
- Design Report finished by October 1, 2001
 - Will include the scope, resource requirements, and schedule for each Run 2b project.
- Dedicated Run 2b project review by the AAC in December of 2001



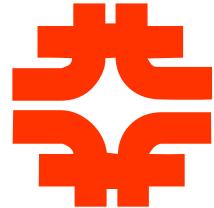
Present Technical Progress on Run 2b Projects

- Slip Stacking
 - Testing of DSP algorithms in low level RF has begun
 - Low intensity beam trials to start before May shutdown
 - Simulations of slip-stacking without beam loading replicated
 - Simulations of slip-stacking with beam loading underway.
- Beam loading
 - RF feedback at fundamental operational
 - Prototype RF feedback at $m=1$ lines to be tested summer 2001
 - IIR design awaiting results of simulations of slip-stacking with beam loading.



Present Technical Progress on Run 2b Projects

- AP5 line
 - Reverse proton tuneup for shot setup at about 1/2 hour
 - Redesign of 8 GeV AP3-AP1 lattice almost complete.
 - Power supply reconfiguration of 8 Gev AP3-AP1 and 120 GeV AP1 to take place during July 2001 shutdown
 - Transfer function measurements of 8 Gev P1-AP3 beam lines to begin May 2001.
- AP2 & Debuncher Aperture Upgrades
 - Optics redesign has been started
 - Transfer function measurements during May 2001 shutdown
 - BPM system design with CDF (Ohio State) has begun
 - Final installment of Debuncher Injection region improvements to be done during May 2001 shutdown



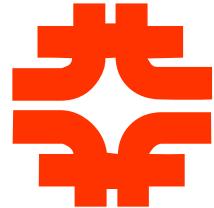
Present Technical Progress on Run 2b Projects

- Solid Lens R&D

- ANSYS mechanical and magnetic model of present lens nearly complete.
 - Initial MARS tracking results using ANSYS output as input have been completed (CDF- Bussey)
 - Fatigue tests of diffusion bonding underway.
 - 8 cm diffusion bonded mechanical design underway. Fabrication to begin in Fall 2001
 - No-beam Target Sweeping tests to begin Summer 2001

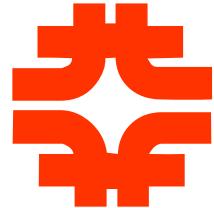
- Accumulator Cooling

- Not started



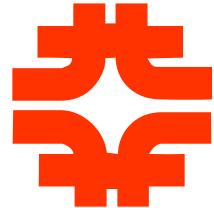
Present Technical Progress on Run 2b Projects

- Recycler Electron Cooling
 - High voltage testing of Pelletron well underway
 - Awaiting approval of SAD for electron beam re-circulation tests.
 - Construction of long beam-line mock-up well underway.
 - Preliminary civil construction design for MI-30 has been started.
- Debuncher Lattice Upgrades
 - Definition of beam studies just starting.
- Linac Ion Source
 - Not started



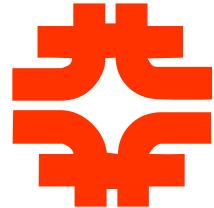
Present Technical Progress on Run 2b Projects

- TEV Tune shift compensation
 - Prototype system installed in TEVATRON
 - Tune shift of bunches observed
 - Future plans are awaiting outcome of TEV tests.
- Booster ramped correctors
 - Single sector linear electronics tested.
 - Power supply limitations require global software control.
- Booster cogging
 - First prototype successfully tested but caused large radial position excursions
 - Second prototype is built and lab tests are nearly complete. Beam tests will start before summer.



Present Technical Progress on Run 2b Projects

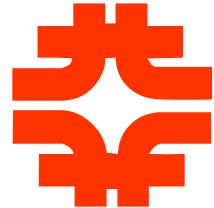
- TEV. Long dampers
 - Design of 36 x 36 digital under-sampled system has begun
- TEV Beam loading
 - Not started
- Liquid Lens R&D
 - Just finished second Fermilab review of BINP project.
 - 3rd lens prototype under construction with new titanium alloy.
 - Fermilab will receive liquid lithium magnetic pumping system this summer.
 - Fermilab will receive power supply this fall.



Estimated Cost of Run 2b Projects

(WPAS version)

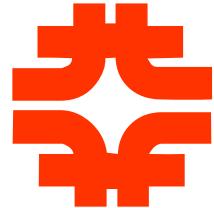
	FY01	FY02	FY03	FY04	FY05	Run IIb		Start Date	Operational Date
	Total	Total	Total	Total	Total	Total			
PS	249	367	389	231	0	1235		Mar - FY01	Mar - FY04
Linac	149	167	139	231	0	685		Mar - FY01	Jun - FY04
Ion Source R&D	149	167	139	231	0	685		Mar - FY01	Jun - FY04
Linac RFQ	0	0	0	0	0	0		-	-
Booster	100	200	250	0	0	550		Apr - FY01	Jul - FY03
Booster Cavities	0	0	0	0	0	0		-	-
Ramped Correctors	75	100	125	0	0	300		Feb - FY01	Jul - FY03
Longitudinal Dampers	0	0	0	0	0	0		-	-
Transverse Dampers	0	0	0	0	0	0		-	-
Cogging	25	100	125	0	0	250		Oct - FY02	Jul - FY03



Estimated Cost of Run 2b Projects

(WPAS version)

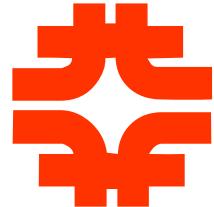
	FY01	FY02	FY03	FY04	FY05	Run IIb	Start Date	Operational Date
	Total	Total	Total	Total	Total	Total		
MI	77	693	0	0	0	770	Oct - FY02	Aug - FY02
RF	77	693	0	0	0	770	Oct - FY02	Aug - FY02
Slip Stacking	77	693	0	0	0	770	Oct - FY02	Aug - FY02
Low Level	34	306	0	0	0	340	Oct - FY02	Aug - FY02
Beam Loading Compensation	43	387	0	0	0	430	Sept - FY01	Aug - FY02
RF Power Upgrade	0	0	0	0	0	0	-	-
RR	2384	5637	5960	600	0	14580	May - FY01	Aug - FY03
Electron Cooling	2050	2700	4200	600	0	9550	Mar - FY01	Aug - FY03
AP5 line	334	2937	1760	0	0	5030	Oct - FY02	Jun - FY03
Design	110	115	125	0	0	350	Jan - FY01	Jun - FY03
Civil	211	1409	810	0	0	2430	Oct - FY02	Jun - FY03
Technical Components	13	1413	825	0	0	2250	Nov - FY02	Jun - FY03



Estimated Cost of Run 2b Projects

(WPAS version)

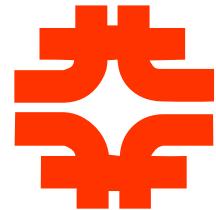
	FY01	FY02	FY03	FY04	FY05	Run IIb	Start Date	Operational Date
	Total	Total	Total	Total	Total	Total		
Pbar	329	673	1128	5824	5987	13940	Feb - FY03	Jul - FY05
Target Station	97	291	291	1291	1000	2970	Jun - FY02	Jun - FY05
Solid Lens R&D	97	291	291	1291	1000	2970	Jun - FY02	Jun - FY05
Liquid Lens R&D	0	0	0	0	0	0	-	-
Beam Sweeping	0	0	0	0	0	0	-	-
Debuncher	197	197	197	2368	2567	5525	Jul - FY03	Jul - FY05
Aperture	197	197	197	1543	1742	3875	Sept - FY02	Jul - FY05
BPM System	62	62	62	310	224	720	Nov - FY02	Jun - FY05
Moveable Quads	135	135	135	808	538	1750	Jan - FY02	Jun - FY05
Dipole Beam Pipe	0	0	0	425	980	1405	Jan - FY04	Aug - FY05
DRF1-1	0	0	0	0	0	0	-	-
Lattice Upgrades	0	0	0	825	825	1650	Dec - FY04	Jul - FY05
Coupling Correction	0	0	0	350	350	700	Dec - FY04	Jul - FY05
Resonance Correction	0	0	0	350	350	700	Dec - FY04	Jul - FY05
Gamma - t ramp	0	0	0	75	75	150	Dec - FY04	Jul - FY05
Dispersion Correction	0	0	0	50	50	100	Dec - FY04	Jul - FY05



Estimated Cost of Run 2b Projects

(WPAS version)

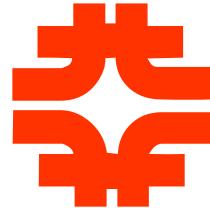
	FY01	FY02	FY03	FY04	FY05	Run IIb		Start Date	Operational Date
	Total	Total	Total	Total	Total	Total			
Accumulator	0	0	0	1400	2270	3670		Jan - FY04	Aug - FY05
StackTail Betatron Cooling	0	0	0	450	740	1190		Jan - FY04	Aug - FY05
Core Tranverse Cooling	0	0	0	450	740	1190		Jan - FY04	Aug - FY05
StackTail Pickups	0	0	0	500	790	1290		Jan - FY04	Aug - FY05
Beam Lines	35	185	640	765	150	1775		Jul - FY02	Sept - FY04
Beam Position System	0	0	465	155	0	620		Nov - FY03	May - FY04
AP2 line	35	185	175	610	150	1155		Mar - FY02	Dec - FY05
Aperture	35	185	175	610	150	1155		Mar - FY02	Dec - FY05
Left Bends	0	10	0	610	150	770		Nov - FY04	Mar - FY05
Correctors	35	175	175	0	0	385		Oct - FY02	Jul - FY03
Chromatic Correction	0	0	0	0	0	0		-	-
AP1 Line	0	0	0	0	0	0		-	-
EPB dipole replacements	0	0	0	0	0	0		-	-
F17 Cmagnet Replacements	0	0	0	0	0	0		-	-



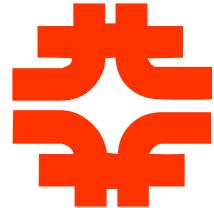
Estimated Cost of Run 2b Projects

(WPAS version)

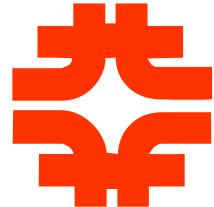
	FY01	FY02	FY03	FY04	FY05	Run IIb		Start Date	Operational Date
	Total	Total	Total	Total	Total	Total			
TEV	1000	1110	555	648	463	3775		Feb - FY01	Dec - FY05
Beam-Beam Tune Shift Compensation	1000	1110	555	648	463	3775		Feb - FY01	Dec - FY05
Beam Loading Compensation	0	0	0	0	0	0		-	-
Longitudinal Dampers	0	0	0	0	0	0		-	-



Labor Profile of Run 2b Projects (WPAS version)

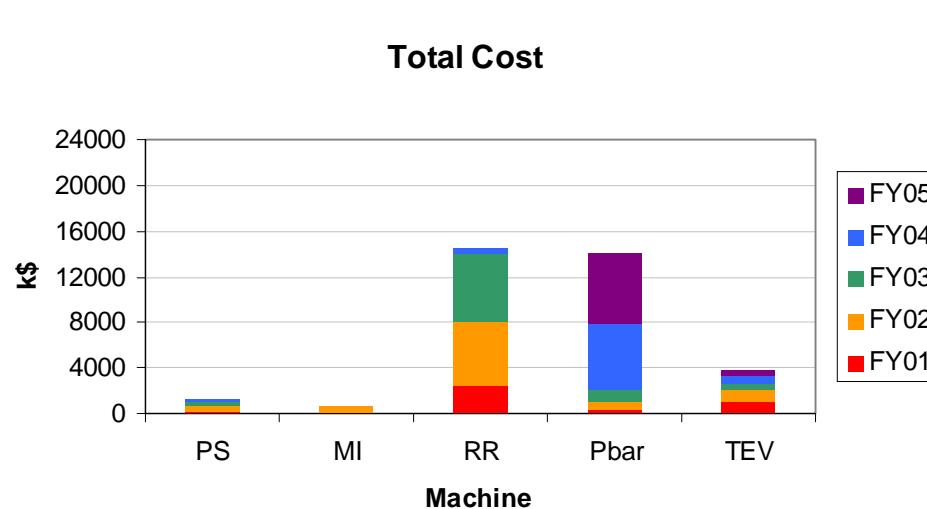
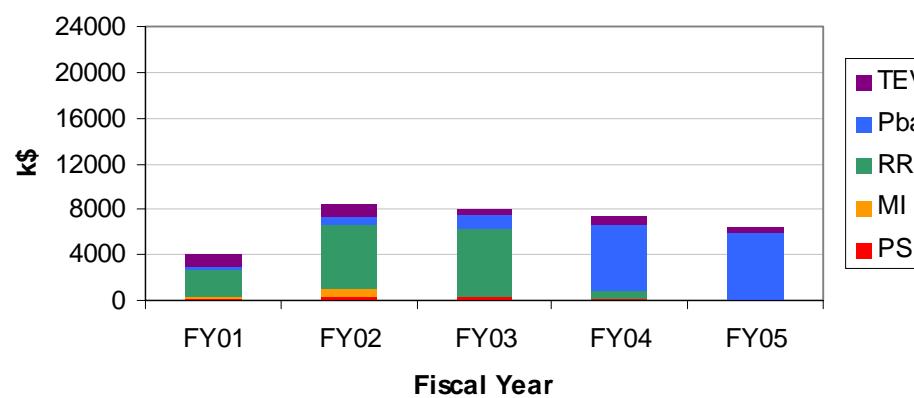


Labor Profile of Run 2b Projects (WPAS version)

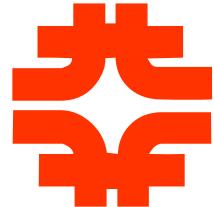


Total Cost for Run IIb

(WPAS version)



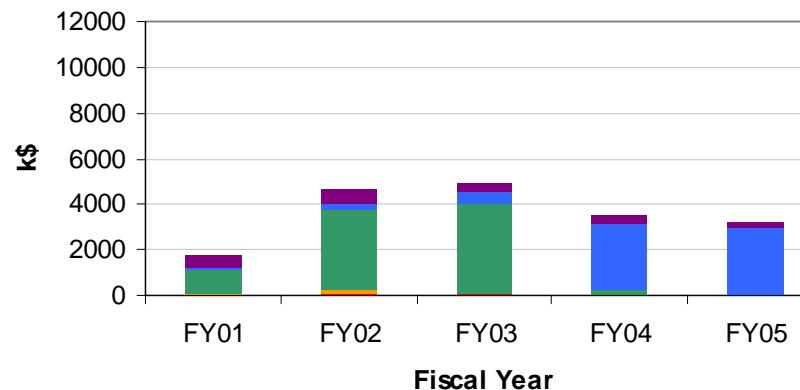
	FY01	FY02	FY03	FY04	FY05	Total
PS	249	367	389	231	0	1235
MI	77	693	0	0	0	770
RR	2384	5637	5960	600	0	14580
Pbar	329	673	1128	5824	5987	13940
TEV	1000	1110	555	648	463	3775
Total	4038	8479	8032	7302	6449	34300



M & S Cost for Run IIb

(WPAS version)

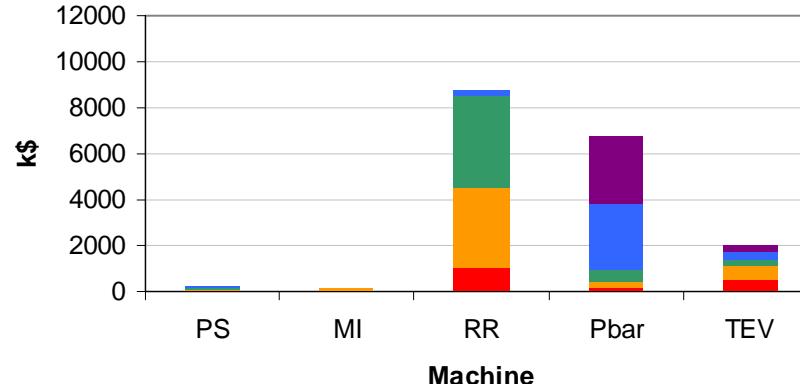
M & S



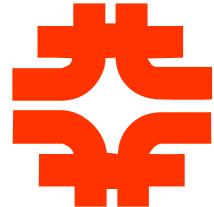
- TEV
- Pbar
- RR
- MI
- PS

	FY01	FY02	FY03	FY04	FY05	Total
PS	43	67	73	38	0	220
MI	20	180	0	0	0	200
RR	1050	3500	4000	250	0	8800
Pbar	145	285	510	2890	2985	6815
TEV	500	600	300	350	250	2000
Total	1758	4632	4883	3528	3235	18035

M & S



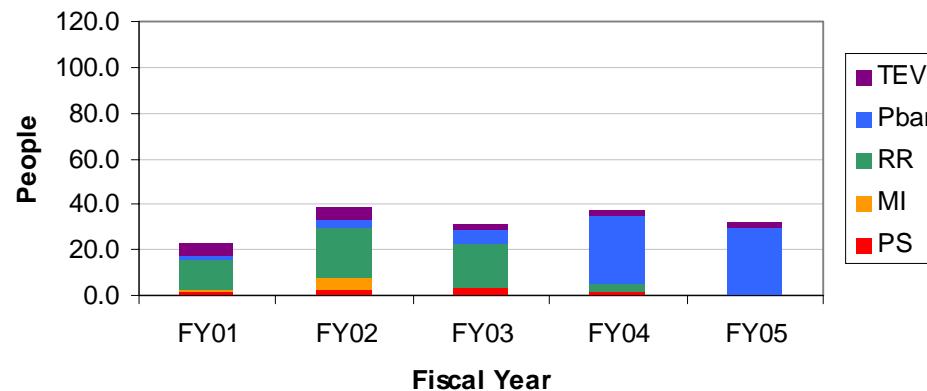
- FY05
- FY04
- FY03
- FY02
- FY01



Labor Cost for Run IIb

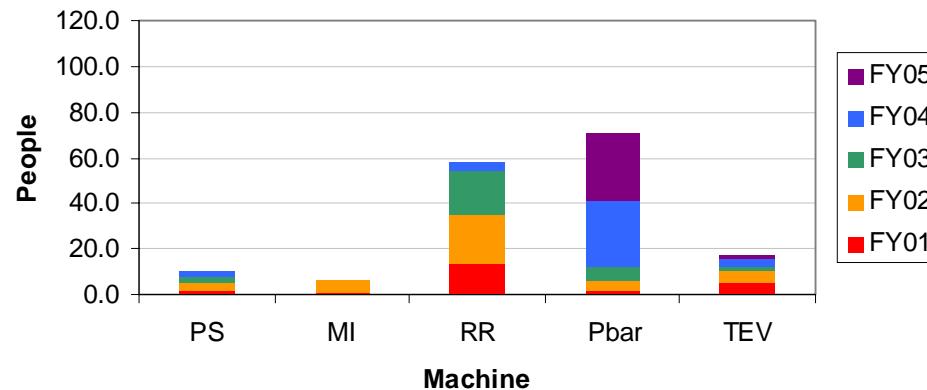
(WPAS version)

Total Labor

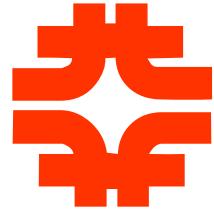


	Labor					
	FY01	FY02	FY03	FY04	FY05	Total
PS	2.1	3.0	3.2	1.9	0.0	10.2
MI	0.6	5.1	0.0	0.0	0.0	5.7
RR	13.3	21.4	19.6	3.5	0.0	57.8
Pbar	1.8	3.9	6.2	29.3	30.0	71.3
TEV	5.0	5.1	2.6	3.0	2.1	17.8
Total	22.8	38.5	31.5	37.7	32.1	162.7

Total Labor



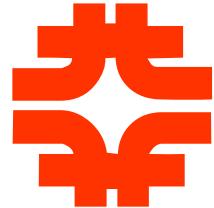
	Labor\$					
	FY01	FY02	FY03	FY04	FY05	Total
PS	206	300	316	194	0	1015
MI	57	513	0	0	0	570
RR	1334	2137	1960	350	0	5780
Pbar	184	388	618	2934	3002	7125
TEV	500	510	255	298	213	1775
Total	2280	3847	3149	3775	3214	16265



Project Schedule

(WPAS version)

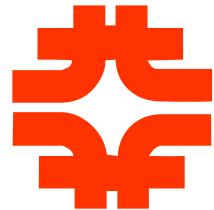
	Y 1	Y 2	Y 3	Y 4	Y 5	
	OND J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S					
PS						
Linac						
Ion Source R&D						
Linac RFQ						
Booster						
Booster Cavities						
Ramped Correctors						
Longitudinal Dampers						
Transverse Dampers						
Cogging						
MI						
RF						
Slip Stacking						
Low Level						
Beam Loading Compensation						
RF Power Upgrade						



Project Schedule (WPAS version)

The Gantt chart illustrates the timeline for the construction of various LHCb detector components. The horizontal axis represents time, divided into five-year periods (Y1 to Y5). The vertical axis lists the components. Most components show a continuous blue bar representing their active construction period.

Component	Start Date (Year)	End Date (Year)
RR	2011-01-01	2014-01-01
Electron Cooling	2011-01-01	2014-01-01
AP5 line	2011-01-01	2014-01-01
Design	2011-01-01	2014-01-01
Civil	2011-01-01	2014-01-01
Technical Components	2011-01-01	2014-01-01
Pbar	2011-01-01	2014-01-01
Target Station	2011-01-01	2014-01-01
Solid Lens R&D	2011-01-01	2014-01-01
Liquid Lens R&D	2011-01-01	2014-01-01
Beam Sweeping	2011-01-01	2014-01-01
Debuncher	2011-01-01	2014-01-01
Aperture	2011-01-01	2014-01-01
BPM System	2011-01-01	2014-01-01
Moveable Quads	2011-01-01	2014-01-01
Dipole Beam Pipe	2011-01-01	2014-01-01
DRF1-1	2011-01-01	2014-01-01
Lattice Upgrades	2011-01-01	2014-01-01
Coupling Correction	2011-01-01	2014-01-01
Resonance Correction	2011-01-01	2014-01-01
Gamma - t ramp	2011-01-01	2014-01-01
Dispersion Correction	2011-01-01	2014-01-01



Project Schedule

(WPAS version)

	Y 1	Y 2	Y 3	Y 4	Y 5
	OND J F M A M J J A S	OND J F M A M J J A S	OND J F M A M J J A S	OND J F M A M J J A S	OND J F M A M J J A S
Accumulator					
StackTail Betatron Cooling					
Core Tranverse Cooling					
StackTail Pickups					
Beam Lines					
Beam Position System					
AP2 line					
Aperture					
Left Bends					
Correctors					
Chromatic Correction					
AP1 Line					
EPB dipole replacements					
F17 Cmagnet Replacements					
TEV					
Beam-Beam Tune Shift Comp					
Beam Loading Compensation					
Longitudinal Dampers					